THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[FOURTH SERIES.]

"..... per litora spargite museum,
Naiades, et circùm vitreos considite fontes:
Pollice virgineo teneros hic carpite flores:
Floribus et pictum, divæ, replete canistrum.
At vos, o Nymphæ Crateridès, ite sub undas:
Ite, recurvato variata corallia trunco
Vellite muscosis e rupibus, et mihi conchas
Ferte, Deæ pelagi, et pingui conchylia succo."
N. Parthenii Giannettasii Ecl. 1.

No. 103. JULY 1876.

I.—*On the Affinities of the Anthozoa Tabulata.*

By Dr. Gustav Lindström*.

Since Milne-Edwards and Haime first laid the foundations of their classification of the Anthozoa in their great works, a large amount of material has been amassed on various hands, and necessitates on nearer investigation a revision and, as an unavoidable attendant of the progress of science, a rearrangement of the various parts of the system. But amongst all the orders of Anthozoa none seems to stand so much in need of revision as that of the Tabulate Corals; and the purport of the present paper is to demonstrate that this order is composed of genera belonging to quite different classes of the animal kingdom, and having no zoological affinities with one another; whence it results that the order Anthozoa Tabulata must be broken up and its constituent genera distributed amongst other classes and orders previously known. Having examined almost all genera belonging to the Tabulate Corals, I cannot but concur in the opinion, which Prof. Verrill†, as far as I know,

* Published in the Proceedings of the Swedish Academy of Sciences, 1873, and translated, with amendments and additions, by the author. Communicated by Dr. H. Alleyne Nicholson.

† "On the Zoological Affinities of the Tabulate Corals," Proc. Amer. Assoc. Adv. Sci. 1867, p. 150; "Review of Corals and Polyps of W. Coast of America," Trans. Conn. Acad. vol. i. 1868–70, p. 518; "Affinities of Palæozoic Tabulate Corals with existing Species," Silliman's Journ. 1872, p. 187. See also W. S. Kent, Ann. & Mag. Nat. Hist. 1870, vi. p. 384.

was the first to express, that the order Tabulata is founded on a character too artificial to allow of its retention.

The chief distinctive feature of the Tabulate Corals is stated to be the presence of tabulæ or floors, representing what may be aptly called the horizontal element of the coral, in direct opposition to the vertical elements, viz. the wall and the septa. According to my views of the different parts of the corallum, these tabulæ are completely homologous with the dissepiments of the other corals. They consist of sclerenchyma secreted by the basal parts of the animal, within the wall and between the septa. In many Cyathophylloids it is very easy to see how the vesicular dissepiments in the centre of the visceral chamber, where the septa are absent, pass without the least interruption into larger, elongated, faintly convex, and horizontal laminæ, or even into a single lamina, which, being smooth and more or less horizontal, can in no way be distinguished from a complete tabula. In longitudinal sections of the Cyathophylloids, tabulæ are seen in one place and small vesicular dissepiments in another, at the centre of the same individual. We can thus see without any difficulty how the lateral vesicular dissepiments are changed into tabulæ. In some Cyathophylloids in which the cup is deep there seems to exist an exception, in so far that there is apparently an exterior zone of vesicular dissepiments, the laminæ composing which are directed in a slanting manner outwards and upwards, and which have no connexion with an interior zone of horizontal tabulæ. This sharp distinction is due to the circumstance that those parts of the dissepiments which are simultaneously formed do not lie in the same plane, but are elevated at the sides and deeply depressed centrally. Thus the tabulæ, lying deep down centrally, are environed laterally by older masses of dissepimental tissue; and this causes an apparently distinct line of demarcation between the central and peripheral zones (see, for example, Edw. & Haime, Pol. Foss. des Terr. Pal. pl. viii. fig. 4 *a*). In other genera, again, as *Diphyphyllum*, *Columnaria*, and *Lithostrotion*, the dissepiments are in a very high degree, as it were, pushed aside and the septa somewhat shortened; whilst in other genera, such as *Pholidophyllum* and some *Cystiphylla*, the dissepimental vesicles have quite disappeared, and the septa are reduced to a minimum, being sometimes wholly wanting, or only faintly indicated by rows of sparsely developed spines. This diminution of the septa and dissepiments is of necessity accompanied by an enlargement of the smooth central space, which is seen at the bottom of the cup to be uncovered by the septa and to be formed by the tabulæ. This surface is continued without interruption between the septa, and occupies

the place of the dissepiments (as, for example, in some *Ptychophylla*), just in the same way as the dissepiments may occupy the place of the tabulæ. This identity of the tabulæ and dissepiments is perhaps in no forms so evident as in the *Cyathophylla*, in which there are frequent passages between both these sclerenchymatous secretions, whereby it is demonstrable that they are immediate continuations or transformations of one another. On the other hand, there are Heliolitidæ in which a longitudinal section shows dissepimental tissue of quite a Cystiphyllidean type partially superseding the usual regular tabulæ. A compound *Cystiphyllum* (such as *C. cylindricum*, Lonsd.), where the individual corallites are often very narrow, and are each traversed by crowded and regular horizontal dissepiments, quite resembles a "tabulate" coral in its longitudinal section, and cannot be distinguished from one so far as this particular point is concerned. The fact seems to be that some corals which, like *Syringopora* and *Columnaria*, have been placed amongst the Tabulata on account of their "floors," are rather to be regarded as Rugose corals. It is also very difficult in longitudinal sections to see any great difference between a *Michelinia* or *Emmonsia* and a *Cystiphyllum*, all alike having the visceral chamber filled up with abundant vesicular dissepiments. Besides, there are several recent corals of quite remote zoological affinities, such as *Tubipora*, which are provided with tabulæ, thus resembling *Syringophyllum* and *Syringopora*. Duncan has also shown how *Lophohelia* is provided with tabulæ (Madrepor. of the 'Porcupine' Exp. p. 323). Amongst Mesozoic genera, *Clausastræa* and *Cyathophora*, according to De Fromentel (Intr. Pol. Foss. pp. 278, 280), have tabulæ so strongly developed as to lead him to place them in the Tabulata. I am of opinion, therefore, that there is no difference of kind between dissepimental tissue and tabulæ, both belonging to the same sort of endotheca. The Rugose corals therefore, and some other forms, are just as much tabulated as the Tabulata, and the latter are just as much dissepimental as the former, there being in this respect a complete agreement between the two groups.

There are, moreover, other animals which in their hardened tissues possess tabulæ, or have the cavity formerly occupied by their body divided into compartments by transverse floors placed at tolerably regular intervals; and these have therefore been regarded as Tabulate corals, though I think there is no longer any reason for retaining them amongst the Anthozoa. This is the case with *Millepora*, and probably also with *Axopora*. In a former paper ("Anthozoa Perforata of Gotland," p. 3) I endeavoured to show that the polypary of *Millepora*

has not the least relationship to that of the Heliolitidæ. In its spongiose mass there are no calicles proper, clearly circumscribed by a wall of their own; nor are there any septa. The animal is sheltered in an irregular tube of the general mass, the texture of which is such that the coral, if Anthozoan, would have to be placed amongst the Perforata. According to the observations of both L. Agassiz and Pourtalès*, the animal of *Millepora* is a true Hydrozoon; and although the latest researches of Moseley ('Nature,' vol. xiii. p. 138) seem to leave it undecided whether it is truly Hydrozoan or Anthozoan, I think it better to remove the genus from the Anthozoa—the more so as the above naturalists, who alone have described the animal in its living state, are of this opinion †. At the same time we may discard all conclusions that might be drawn as to the systematic position of the supposed relations of *Millepora*. Through the researches of Verrill ‡, it is known that the animal of *Pocillopora* in no way resembles that of *Millepora*, but that the former is a true Anthozoan, akin to the Oculinidæ and *Stylophora*.

The Silurian genus *Labechia*, E. & H., also seems to partake of Hydrozoan characters. In its earliest stages of growth this fossil consists of a very thin circular disk, with concentric lines of growth beneath, and having the superior surface studded with blunt spines, which radiate from the centre, and also coalesce and form continuous ridges. In this state it reminds one of nothing more than the sclerobasis of the Hydrozoan genus *Hydractinia*; and the only difference seems to be that *Labechia* is entirely calcareous, whilst *Hydractinia* is corneous. During the course of growth the primitive disk of *Labechia* is increased in thickness by the addition of successive thin strata, which closely conform to the subjacent fundamental crust, being elevated where the spines are situated. As these successive layers leave a small space between them, and are in themselves very thin, they give rise to a false appearance of tabulæ. Milne-Edwards considers (Hist. Nat. Cor. iii. p. 284) that the spines are projections upwards from the rim of the supposed calicular wall; but there is not the least trace of any wall circumscribing any calicle, or of any septa, and these spines are only the last ones of the uppermost stratum superimposed on

* Pourtalès, "Deep-Sea Corals," Illustr. Cat. Mus. Cambr. no. iv. p. 56.

† If, as Dr. Duncan states, in consequence of the last researches of Mr. Moseley ('Nature,' April 13th, 1876), *Millepora* is really an Anthozoan, it deviates in a high degree from other Corals, and can by no means be allied with the Heliolitidæ.

‡ "Review of Corals of W. Coast of America," Trans. Conn. Acad. vol. i. pp. 2, 523.

their predecessors, one beneath the other, like so many inverted funnels. It was recently pointed out to me by G. Eisen that there are large specimens found in Gotland combining the peculiar features of *Labechia* with those of *Cœnostroma*; so, perhaps, there may also be reason to eliminate the latter from the Anthozoa.

Next we have to consider a great variety of other fossils which are generally stated to be Tabulata, but which in reality are Bryozoa. Foremost stands the genus *Monticulipora*. If numerous specimens of the common Silurian *M. petropolitana*, Pand., be closely scrutinized, it will be seen that its semiglobose colony, so closely resembling a *Favosites* in its initial development, has an origin that could hardly be suspected. It begins, indeed, as a Bryozoon, as a *Discoporella*, as what Hall has termed *Ceramopora imbricata* (Pal. N. Y. vol. ii. p. 169, pl. 40 E. figs. 1 *a*–1 *i*). There can be no doubt that this is closely allied to the recent *Discoporella* (see Fr. Smitt, Œfvers. Vet. Akad. Förhand. 1866, p. 476, pl. xi. fig. 4). The basal surface of a *Monticulipora*, when the epitheca is very thin, clearly shows that it is in its first origin a *Ceramopora*. The smallest *Ceramoporæ* which I have hitherto seen consist of a thin circular disk with elevated edges. From the smooth centre of the superior surface four or five wedge-shaped zoœcia radiate outwards, each of a length of $\frac{1}{3}$ millim., their mouths being oblique, with the inferior lip somewhat protracted. On both sides of the mouth there is a short, pointed spine. In its interior such a zoœcium is transversely divided by some irregular tabulæ. The interstitial ribs, which are so characteristic of the Discoporellidæ, are also distinctly seen between the zoœcia of *Ceramopora*. New zoœcia are budded forth in quincunx from the corners of the old zoœcia; and in the periphery of the colony they become more crowded, having the mouth oval and erected. In the interstices is seen what might be taken to be a cœnenchyma; but this in reality is composed of nothing but smaller irregular zoœcia. When the colony has spread out laterally, there are seen at the sides of the first smooth centrum several others regularly distributed on the surface, from which zoœcia radiate, just as if the disk were composed of an aggregation of coalescent initial buds. When the colony has thus gained the expanse of an inch or more, the zoœcia grow vertically upwards; and the colony by-and-by assumes a semiglobular shape, and is converted into a *Monticulipora*. All the zoœcia are then tubular, their mouths quite circular, and armed with a pair of very short spines, their size varying in different cases. The larger zoœcia have around them either an empty space or, as above stated, a cellular

tissue, resembling a cœnenchyma, and consisting of smaller circular or polygonal tubes. The walls of the zoœcia are solid, without any perforations, and interiorly quite smooth and destitute of projecting ridges or septa. The tabulæ are very irregular in the large tubes, being oblique or deeply sunk at the walls; in the narrower tubes they are dense and regular. The large zoœcia are clustered in groups at tolerably regular intervals, each group of six or eight members. In Upper-Silurian specimens they very seldom project above the surface, and do not form the strange monticules which are so common on the surface of the Russian Lower-Silurian specimens. I suppose that these clusters are continuations from the original and larger zoœcia, which were budded out round the smooth centra when the colony was in its *Ceramopora* stage. In some there is seen a sort of "reversion," the zoœcia on the surface of *Monticulipora* having again assumed the unmistakable characters of a Bryozoon, becoming oblique, and radiating as in a *Ceramopora*. Longitudinal sections, however, demonstrate that there is a direct continuation from the tubes of the *Monticulipora* into those of the *Ceramopora*, or that the former again have changed into the latter.

A more common and more protean *Monticulipora* is that which Hall described as *Trematopora ostiolata* (Pal. N. Y. vol. ii. p. 152, pl. 40. fig. 5), and which I consider to be identical with *M. papillata*, M'Coy (Edw. & Haime, Brit. Foss. Cor. p. 266, pl. 62. figs. 4, 4 *a*), with *Thecostegites hemisphæricus* (Ferd. Römer, 'Tennessee,' p. 25, pl. ii. figs. 3, 3*a*), and with *Stictopora malmoënsis*, Kjerulf (Veiviser, p. 21, fig. 29). All these are only different stages of growth of the same species, viz. *Monticulipora ostiolata*, the fully developed form belonging to this genus. The *Discoporella* stage, the initial one, consists of a thin crust covered with small tubular zoœcia, varying in form, with oval or crescentic mouths, or having the sides faintly indented, with a short spine at each indentation. Interstitial ribs are also present. The smallest colony I have seen is 3 millims. in diameter; and, as in the *Discoporellæ* in general, the centre is smooth and concave, without zoœcia, but surrounded by cells radiating in all directions. As this primitive colony always spreads as a thin membrane over the object on which it is fixed, its shape depends on the shape of its basis; and in consequence the polyparium is discoidal, globular, or branching; rarely it is semiglobular, on its own free basis. From this *Discoporella* stage it passes into what may aptly be called the *Fistulipora* stage. The genus *Fistulipora* is, indeed, chiefly made up of Silurian and Devonian Bryozoa. The cells are now elevated, some being angular, the walls being bent inwards in 3–4 (or sometimes only 1–2) folds, which

project into the interior as longitudinal ribs having the appearance of septa. It is possible that these longitudinal ribs are connected with the cleavage of the cells into two or more—a mode of increase which is shown by sections to have often occurred, though it is difficult to see why some cells should have grown to such a length without fission taking place. Good information on these points can be gathered from an elaborate paper by Rominger*, who, as early as 1866, stated his opinion that *Chætetes*, *Monticulipora*, and other related forms were referable to the Bryozoa, though he had had no opportunity of observing how they had grown out of *Discoporella* and *Ceramopora*. Each cell is now surrounded by a mass of small, vertical, circular or polygonal tubes, having the appearance of a cœnenchyma. Consequently the surface of the polyzoarium quite resembles that of *Heliolites*, next to which genus *Fistulipora* has also been ranged. At regularly distant points there are smooth patches without any cells. Such patches are in vain looked for in the true Heliolitidæ; and in these there are moreover generally twelve septa, with which the longitudinal ribs of the *Fistulipora*, variable as they are in place and number and often wanting, can in no way be considered homologous. All the cells, as well as the interstitial tubes, are traversed by tabulæ of the same incomplete type as those which characterize *Monticulipora*. Finally, there is a third stage in the growth of this Bryozoon. The interstitial cells now become covered by a thin, smooth, calcareous membrane, resembling that which forms the maculæ, leaving the larger cells (or zoœcia proper) open, and giving their orifices a new shape. They become circular or oval, with a much thicker wall than before, and they project high above the surrounding smooth surface. There is now such a dissimilarity to *Fistulipora*, that only the circumstance that both the *Fistulipora* stage and the one just mentioned are seen in the same polyzoarium could convince one that they are really only different stages of growth of the same species. This third stage I have called the *Thecostegites* stage, in consequence of a certain likeness to the genus *Thecostegites*, which caused Ferd. Römer to include this Bryozoon in that genus. This phase of growth more often changes into a *Monticulipora* than does the preceding or *Fistulipora* stage. The *Monticulipora* thus produced is remarkable for its regular "monticules," arranged in quincunx, and formed at the points where seven or eight large cells are clustered, just as in *M. petropolitana*,

* "Observations on *Chætetes* and some related Genera, in regard to their Systematic Position, with an appended Description of some new Species," Proc. Acad. Nat. Sci. Philad. 1866, p. 113.

though not always formed at these points. On the contrary, the bare patches, or "maculæ" of authors (the thin, smooth, calcareous membranes which have completely covered the orifices of several cells), are also sometimes elevated so as to form "monticuli." This is the case, at least, with *M. ostiolata*, and with Russian specimens of *M. petropolitana*, where monticules formed by the large cells are almost wholly covered by a membrane, which forms a macula. Maculæ are seen only where there are monticuli, or groups of large cells. The excellent figures of some Silurian *Monticuliporæ* in the works of Milne-Edwards (see Pol. Foss. des Terr. Pal. pl. xix.) show the same feature. This, however, is not peculiar to the Palæozoic Bryozoa; since J. Haime has described Bryozoa of the genera *Heteropora* and *Neuropora*, from the Jurassic formations of England and France, as not only having "maculæ" hiding the cells beneath them but also monticuli ("mamelons") and tabulæ, just as in *Monticulipora* ("Bryozoaires Foss. de la Form. Jurass.," Mém. Soc. Géol. de France, 2e sér. t. v. part 1, p. 207). The maculæ in question may be identical with the smooth patches which are so prominent in the Cretaceous Bryozoan family Clusidæ; and it may be doubted whether this phenomenon, which was periodical and not constant, is not of the same nature as the calcareous membrane which is so often seen to close the orifices of the cells in recent Bryozoa (e. g. *Retepora intricaria*, Fr. Smitt). It occurs also in single cells of some species of *Chætetes* and *Callopora*, where it is seen in all stages, from a mere commencement round the wall of the zoœcium to its complete form. Rominger regards this covering as an operculum, which it cannot be, the formation of such a cover necessarily proceeding in a way quite opposite to what obtains in the Bryozoa just mentioned. Moreover there seems to be no instance of the genuine opercula of certain Bryozoa having ever been preserved in a fossil state, as these structures are of a corneous nature. It is remarkable that such unquestionable corals as the Favositidæ often have had their calices closed in a somewhat similar way. In these the orifices of single calices are closed by a thin, operculoid, calcareous membrane, formed, as in the Bryozoa, by successive strata, which grow concentrically from the wall towards the centre, where they are often left incomplete and not filled up. There are also species in which several adjoining calices are covered in a similar manner. In the Favositidæ these covering membranes are clearly of an epithecal nature, being a direct continuation of the epitheca, which spreads successively over the calicles, as may be seen nowhere so clearly as in the strange Devonian *Favosites turbinata*, Bill.

Besides the difference in their structure, there is also this dissimilarity between these analogous structures in the Favositidæ and the Bryozoa—that in the latter they are regular, and cause the characteristic patches and eminences, whereas in the former they spread along the upper border of the epitheca, and thence become scattered over single calices.

In the Palæozoic strata there occur, besides the now described *Monticulipora*, a great many related Bryozoa. Of this nature, for instance, is the Silurian *Monticulipora* (*Callopora*) *Fletcheri*, E. & H., with its regular oblique maculæ, and others with narrow branches. Allied to these is a *Trematopora* with jointed branches; and this genus leads to others, such as the common *Glauconome disticha*, Goldf. (= *Vincularia nodosa*, Eichw.), which also had their stems divided by joints, just as in the recent *Bugula Murrayana*, Bean, and *Cellaria borealis*, Busk.

In the next place, I may give a list of all the genera which by some authors are still regarded as Tabulate Corals, but which, in my opinion, must be eliminated from that class, and numbered amongst the Bryozoa. It may be objected that most of these are provided with tabulæ, which have never as yet been observed in the zoœcia or proper cells of the Bryozoa, but only in the interstitial cells (Fr. Smitt, *loc. cit.* pp. 476, 477). The development of the Palæozoic species, however, out of polyzoaria which have such a decided affinity to the recent *Discoporellæ* and others, coupled with the total absence of all septa, points with logical necessity to the above conclusion as to their systematic position. They must be placed with the Bryozoa, in the same way that the Cirripedia were removed from the Mollusca to the Crustacea, when their development became known. Even as regards some genera the development of which is still unknown, there are points of structural affinity with unquestionable Bryozoa which render their reference to this class highly probable.

Callopora, Hall (Pal. N. Y. vol. ii. p. 144). To this genus belong *Monticulipora Fletcheri*, E. & H., and *M. pulchella*, E. & H.

Ceriopora, Goldf. (Petref Germ. i. p. 32). According to D'Orbigny this genus is Bryozoan; but Milne-Edwards identifies the Palæozoic species with *Monticulipora*.

Chætetes, Fischer von Waldheim (Oryct. Gouv. de Mosc. p. 159). Later authors have given this genus a much greater expansion than that allowed to it by Fischer, who included in it *C. radians* and its varieties. D'Orbigny (Cours de Pal. vol. ii. p. 110) refers some species to the Bryozoan genus *Polytrema*, Risso, and retains only four as corals. Lonsdale

(Geol. Russia, i. p. 593), as well as Eichwald (Leth. Ross. i. p. 475), includes under this name the species of both *Monticulipora* and *Chætetes*. Milne-Edwards at first adopted the same course, but finally (Hist. Nat. des Cor. vol. iii. p. 270) separates the species with maculæ (=verrucæ or monticuli) under the name of *Monticulipora*, and retains *Chætetes* for the species with calicles of the same size, thereby approaching *Stenopora*.

?*Cladopora*, Hall (*loc. cit.* p. 137). Embraces species of *Favosites* and *Cænites*, the latter being probably a Bryozoon.

?*Cænites*, Eichw. (Zool. Spec. i. p. 179).

Constellaria, Dana (U.S. Expl. Exped. Zooph. p. 537). Possesses star-shaped monticules, and is synonymous with *Stellipora*, Hall. Rominger identifies with it *Hellipora*, Meek & Worthen (*loc. cit.* p. 118). According to D'Orbigny the genus is Bryozoan.

Cyathopora, Dale Owen (Rep. Geol. Iowa, 1844, p. 69). According to De Koninck (Anim. Foss. p. 142) this genus is identical with *Monticulipora*.

Dania, E. & H. (Comptes Rend. t. xxix. p. 261).

Dianulithes, Eichw. (Zool. Spec. i. p. 180). Typical species *D. detritus*, Eichw., = *Monticulipora Panderi*, E. & H.

Fistulipora, M'Coy (Pal. Foss. p. 11). Under this generic name have been included fossils which are partly Heliolitidæ and partly *Monticuliporæ* in what I have called the "*Fistulipora* stage" of growth. One of M'Coy's species, viz. *F. decipiens*, is a *Heliolites* in which the septa are aborted; whilst his *F. minor* seems to belong to a group of Polyzoa often described by American palæontologists, especially from the Devonian formation. It seems doubtful whether these species are really identical with *Trematopora*; and Rominger thinks *Hellipora*, Meek & Worthen, to be really a *Constellaria*.

Limaria, Steininger (Mém. Soc. Géol. de France, i. p. 339). Identical with *Cænites*, Eichw.

Lunatipora, Winchell (Append. Rep. on Grand-Traverse Region, p. 89). Possesses a branching polyzoary, with tabulæ.

Monticulipora, D'Orb. (Prodr. de Pal. i. p. 25). In his Elém. de Paléont. ii. p. 109, D'Orbigny places this genus amongst the Bryozoa, next to *Acanthopora*, but unites with it species belonging to different genera and from different formations. Synonyms are *Nebulipora*, M'Coy, and *Rhinopora*, Hall. Some authors also consider *Dianulithes*, Eichw., a synonym of this; but the typical species (*D. detritus*) has no monticuli, sparse tabulæ, and the tubes filled up in a peculiar manner, so as to constitute a separate genus.

Myriolithes, Eichw. (Leth. Ross. i. p. 450). Comprises

different forms. Referable to *Trematopora* or *Cunites*, but not to *Monticulipora* as stated by De Koninck (An. Foss. p. 142).

Nebulipora, M'Coy (Ann. Nat. Hist. 1850, vi. p. 283), = *Monticulipora*.

Orbipora, Eichw. (Leth. Ross. i. p. 484). Comprises discoidal *Monticuliporæ* or *Chætetes*.

Orbitulithes, Eichw. (Zool. Spec. i. p. 180). Identical with *Monticulipora*.

Pharnopora, Hall (Pal. N. Y. vol. ii. p. 46).

Pustulipora, Keyserling (in Schrenk's 'Reise in der Norden Russlands,' vol. ii. p. 101). According to Eichwald (Leth. Ross. vol. i. p. 451), identical with his *Myriolithes*.

Rhinopora, Hall (Pal. N. Y. vol. ii. p. 48). Identical with *Monticulipora*.

Stellipora, Hall (Pal. N. Y. vol. i. p. 79). Identical with *Constellaria*.

Stenopora, Lonsd. (in Strzelecki, Phys. Descr. N. S. Wales, p. 262, and Geol. of Russia, vol. i. p. 631). At first called *Tubuliclidia*.

Stomatopora, Bronn (Leth. Geogn. i. p. 54). Comprises young colonies of *Syringopora*, along with the stolons of Bryozoa of various formations.

Tetradium, Dana (Zooph. p. 701). Related to *Chætetes*.

Trematopora, Hall (Pal. N. Y. vol. ii. p. 149). A branching Monticuliporoid, with characters of the "*Fistulipora* stage."

Verticillipora, M'Coy (Carb. Foss. Ireland, p. 194). A dubious *Chætetes*.

It now remains to pass under review the other genera of the old order of the Tabulata. Since the researches of Dana ('Corals and Coral Islands,' p. 76), Kent (Ann. Nat. Hist. 1870, vi. p. 384), and Verrill (Amer. Journ. Sc. & Arts, 1872, p. 187), there can no longer be any doubt that *Favosites* and the closely related *Ræmeria*, *Emmonsia*, *Striatopora*, *Koninckia*, *Pachypora*, n. gen.*, and *Nodulipora*, n. gen.†, belong

* Pachypora, nov. gen.

Calyces annuliformes, ad summitates ramulorum, oblique semilunati, septis sparsis, spiniformibus. Strata densissima, tenuissime lamellata calyces circumdant, unde hi in superficie spatio aliquanto inter se distantes, muri canaliculis perforati. Species unica *P. lamellicornis* n. (forsitan = *Millepora ramis vagis, punctis sparsis*, Linn., Cor. Baltica, p. 27, fig. xii.) ramos habet complanatos, quorum complures inter se coalescunt et laminas latas formant; calyces annuliformes vel oblique lunati, hi præsertim septis muniti. Tabulæ rarissimæ vel obscuræ. Occurrit ad Visby.

† Nodulipora, nov. gen.

Polyparium turbinatum, totum e nodulis minimis contextum, ceterum

to the family *Poritinæ* of the Perforate Corals. *Beaumontia*, in so far as it can be separated from *Favosites*, belongs also to this group, and not to the Monticuliporidæ. *Laceripora*, Eichw., again, is nothing more than a highly perforated *Favosites*. *Alveolites*, as represented by M.-Edwards (Hist. Nat. des Cor. vol. iii. p. 263), is an assemblage of most heterogeneous fossils, some having perforate walls, septa, and tabulæ, and others totally void of these parts, their only common character being the non-essential one of having the mouths of the tubes oblique and semilunate. This character, however, is far from being always present. Two very common Upper-Silurian species, viz. *A. Fougti*, E. & H., and *A. Labechei*, E. & H., show themselves to be genuine *Favosites*, being primitively provided with erect polygonal corallites, the tubes ultimately becoming reclined, with oblique mouths, as the corallum grows out in a lamellar form, but the perforated walls and the septa being still retained. Of the other species there are some which, as the Devonian *A. suborbicularis* and its allies, are rather referable to *Cœnites*. *A. repens* and *A. seriatoporoides* are finely branched forms, without septa and with few tabulæ, and cannot with any certainty be numbered amongst the corals as long as their initial stages are unknown. *Michelinia*, again, deviates from the Favositidæ through its more fully developed septa, its cystiphylloid dissepiments (tabulæ), and the root-like prolongations given off from the border of the corallites. The perforations in the walls are homologous with the inner openings of these rootlets, and not with the mural pores of the Perforata *. There are so many points of affinity between *Michelinia* and the *Cystiphylla*, that the genus must be included in the same family as the latter. *Chonostegites*, E. & H., resembles an eroded *Michelinia*.

We next have a clearly circumscribed family formed by some genera which are characterized by having twelve septa, all of the same size, and a peculiar cœnenchyma composed of small tabulate tubes. This family consists of *Heliolites*, *Lyellia*, *Plasmopora*, *Calapœcia*, and probably *Thecostegites*. When a longitudinal section of a *Heliolites* is compared with that

et forma et septis *Favositarum*. Epitheca tenuis, longitudinaliter rugosa. Superficies calycigera lata, plana. Calyces inæquales, sæpe in radios crescentes, obovati, angusti vel circulares, polygonii et curvi. Muri incompleti, perforati. Noduli corpore rotundo, processibus tenuibus inter se conjuncti. Partes inferiores vel primariæ polyparii materia calcarea consolidatæ. Superficies calycigera processus radiciformes emittit. Species unica *N. acuminata* n. in Dalhem, Gotlandia, reperta.

* *Favosites maximus*, Troost, is a *Michelinia*, and is perhaps the same as the *M. convexa* of Yandell and Shumard.

of a *Halysites*, the great accordance in their intimate structure is very striking. In both there are the large-sized corallites, and between these a more or less dense cœnenchyma of narrow tabulate tubes. This structure (the "Zwischenwände" of Fischer-Benzon, in his paper "Ueber *Halysites*," p. 12) is of a very variable nature both in *Halysites* and in the Heliolitidæ. Longitudinal sections of *Plasmopora* (*Propora*) *tubulata* and *Halysites catenularius* resemble each other most; but there is also a great similarity in the initial stages of growth in both genera. In all the Heliolitidæ, as well as in *Favosites*, *Syringopora*, &c., the earliest stage of growth is that of a small, narrow, conical polypary affixed to some other fossil along its whole length. In *Favosites* and several other corals, new corallites bud out immediately from the inferior lip of the first corallite. In *Heliolites* and *Halysites*, again, there is first formed the cœnenchyma, as an excrescence of the calicular rim, all around it; and out of this cœnenchyma the new corallites are developed. The difference between the further growth in these last-mentioned genera is only that in *Heliolites* the new corallites group themselves around their parent; whilst in *Halysites* they range themselves in a line, each new one at the side of its predecessor. Both genera agree also in having, as a rule, twelve septa, which are subject to great variations in size in different corallites, being always of the same size in the same corallite. In some species the septa meet centrally and form a kind of columella, which is elevated and styliform in *Heliolites*—but in other forms is alone present, the septa having almost disappeared. Where the corallites are large the septa are generally small or quite deficient, as in *Heliolites megastoma* and *Halysites catenularius*. In those species, again, which have small corallites, as *Halysites escharoides* and *Heliolites inordinatus*, the septa are proportionally more developed. I, then, consider *Halysites* to be a member of the Heliolitidæ; and it is not improbable that *Thecia*, with its twelve septa and dense tubular cœnenchyma, also belongs to the same family. Amongst recent corals *Pocillopora* most closely resembles the Heliolitidæ.

The genus *Battersbyia* I have not seen; but it has been shown by Duncan (Trans. Roy. Soc. 1867, p. 648) to be one of the Astræidæ.

Columnaria (or *Favistella*, which has the priority) is one of the Cyathophyllidæ, as may be seen by its gemmation.

Fletcheria, represented only by *F. tubifera*, E. & H., seems to be a Cystiphylloid of very variable characters. In the smaller varieties the vesicular endotheca has been converted into tabulæ, and the septa have almost disappeared.

Syringopora, finally, cannot, any more than the preceding, be considered a Tabulate coral. In large specimens there is a perfect accordance with the Rugosa. "Costæ" and septa are present; and the mode of growth agrees with that of the Rugosa. The corallum, as in all other Palæozoic corals, commences as a small, narrow, conical corallite, which is reclining and attached. From the inferior lip of the calicular orifice there shoot forth two diverging stolons; and the orifice itself simultaneously is directed upwards at right angles, and becomes circular instead of semicircular. The stolons change into new corallites, which in turn send forth stolons, generally two each, and become simultaneously cylindrical and erect tubes. A network of diverging corallites (=*Aulopora*) being thus formed, the growth of the colony is continued chiefly in a vertical direction, and the *Syringopora* proper begins to propagate itself. The ascending tubes continue to emit from their calicine margins the narrow connecting tubes, often to the number of six, which have a horizontal direction and unite adjoining corallites. Some of these, however, turn upwards, without fusion with neighbouring tubes, thus constituting new corallites, from which in turn connecting processes or new tubes are again produced. In fact, the connecting-tubes and new corallites are morphologically nothing but the stolons, no longer creeping or attached, but suspended freely between the corallites. They have nothing in common with the mural pores of the Favositidæ, which are true lacunæ in the wall, as is characteristic of the Perforata generally. The stolons or connecting-tubes of *Syringopora* are homologous with those expansions of the calicular lip which are so common amongst so many other corals and assume such a variety of shape. Such are the radicular processes which the polype forms during its first growth round its calicle, as in *Omphyma*, where they attain a length of several inches and sustain the coral in an erect position. In those corals, again, which were primitively prostrate and attached to foreign bodies, as in *Pholidophyllum*, *Goniophyllum*, *Rhizophyllum*, and *Cystiphyllum*, the rootlets radiate only from the lip of the attached surface. In others, again, as in several *Cyathophylla*, in *Ptychophyllum*, *Acervularia*, and *Arachnophyllum*, the expansions of the lips of the calicle give rise to those large hooked processes which M.-Edwards called "crampons." In none of the genera just mentioned have I ever observed new corallites budded forth from the crampons or rootlets. This occurs, however, in *Diphyphyllum* (=*Eridophyllum*, E. & H.), in *Lithostrotion*, and in a new genus allied to these. The corallites in this last genus are cornet-shaped, attached, and strongly

fluted by pseudo-costæ. As in *Syringopora*, a pair of diverging stolons shoot out from the lip of the affixed surface. These are converted into new corallites, but after attaining a certain size become detached from their parent; so that a compound colony is never produced. In *Lithostrotion*, *e. g.* in *L. irregulare* and *L. harmodites* (in which true connecting-tubes are present), similar expansions may give rise to new corallites. In some (*Lithostrotion cæspitosum*, Mart., De Koninck, An. Foss. 1872, pl. ii. fig. 2) they were very short, and are seen as knobs on the surface of the corallum. In *Diphyphyllum* the large hooked processes are most numerous, and either coalesce with other corallites, or abut on their epitheca without actual fusion. Often new corallites which grow erect, and thus enlarge the corallum, are produced out of these processes (Edw. & Haime, Pol. Foss. des Terr. Pal. pl. x. fig. 4). It is assumed by various authors that such calicular expansions are only prolongations of the epitheca, and that they are formed of this. These rootlets, however, were in many genera clearly formed only when the corallum was young; and hence they are only found round its lower extremity. In others (as *Lithostrotion*, *Diphyphyllum*, and *Syringopora*) they continued to be formed during life. By sections it can be readily shown that the rootlets are in immediate connexion with the interior calicular walls of the coral, and that they themselves are not only covered by the epitheca, but are also provided with endothecal dissepiments. In *Nodulipora acuminata* this outflow (of rootlets) takes its origin from several corallites in common, and has the form of reclined root-like processes, from which corallites are budded forth and form a new colony at the side of the former.

From what I have here stated concerning the internal structure and mode of propagation of *Syringopora*, it seems to me evident that its systematic place should be rather in the vicinity of *Lithostrotion* and *Diphyphyllum* than of the Favositidæ (as proposed by Duncan), or of *Halysites* (as placed by M.-Edwards).

As a summary of the above statements, I append a list of the genera which constitute the order of the Zoantharia Tabulata of M.-Edwards and Haime, with remarks on what I hold to be their natural place in the zoological system :—

Name of Genus.	To be removed to
Millepora.	Hydrozoa?
Heliopora.	*Alcyonaria* (Moseley).
Polytremacis.	*Alcyonaria.*
Heliolites.	*Heliolitidæ* (special family).
Fistulipora.	Some species to *Heliolites*; others to the Bryozoa.

Name of Genus.	To be removed to
Plasmopora.	*Heliolitidæ.*
Propora.	As there is no difference between them except in the size of the septa (a very variable character), this genus should probably be merged with *Plasmopora*, of which many species are known.
Lyellia.	*Heliolitidæ.* (The original specimen in the Musée du Jardin des Plantes resembles an eroded *Heliolites*).
Axopora.	Hydrozoa ?
Battersbyia.	*Astræidæ* (Duncan).
Favosites, *Emmonsia.*	Subfamily *Favositinæ*, of the *Poritinæ.*
Michelinia.	*Cystiphyllidæ.*
Alveolites.	Partly *Favositinæ*; partly Bryozoa.
Rœmeria, *Koninckia.*	*Favositinæ.*
Chætetes, *Monticulipora*, *Dania*, *Stellipora.*	Bryozoa.
Dekayia.	Bryozoa ?
Beaumontia.	*Favositinæ.*
Labechia.	Hydrozoa.
Stylophyllum.	Hydrozoa ?
Halysites.	*Heliolitidæ.*
Syringopora.	Vicinity of *Lithostrotion* and *Diphyphyllum.*
Thecostegites.	*Heliolitidæ.*
Chonostegites.	= *Michelinia.*
Fletcheria.	*Cystiphyllidæ.*
Pocillopora.	*Oculinidæ* (Verrill).
Cœnites.	Bryozoa ?
Seriatopora.	*Oculinidæ* ? (See Dana, 'Corals and Coral Islands,' 1st ed. p. 70.)
Thecia.	*Heliolitidæ* ?
Columnaria.	*Cyathophyllidæ.*

In conclusion, I may attempt a provisional arrangement of the two most important families of the old group of the Tabulata :—

I. Subfamily Favositinæ.

(Family *Poritinæ*. Order *Perforata*.)

Genus 1. *Favosites*, Lam.
2. *Favositipora*, Kent.
3. *Rœmeria*, Edw. & H.
4. *Striatopora*, Hall.
5. *Pachypora*, Lindstr.
6. *Nodulipora*, Lindstr.
7. *Koninckia*, E. & H.
8. *Beaumontia*, E. & H.

II. Family Heliolitidæ.

Genus 1. *Heliolites*, Dana.
2. *Plasmopora*, E. & H. (inclus. *Propora*).
3. *Lyellia*, E. & H.
4. *Calapœcia*, Billings.
5. *Thecostegites*, E. & H.
6. *Halysites*, Fischer.
7. *Thecia*, E. & H. (?).

It is at present very difficult to state the exact affinities of the last family with any certainty as regards other previously known groups, whether *Helioporæ* or others.

Addendum.—When this paper, now translated with some corrections and additions, was first published in the 'Proceedings of the Swedish Academy of Sciences,' 1873, I was not aware that Dr. Duncan had, in 1872, published his views on the Tabulate Corals in the Reports of the British Association for 1871. On several points there is some diversity between his opinions and mine; and I have in some places added my reasons for deviating from his conclusions. M. G. Dollfus, who also lately proposed a new classification of the Palæozoic corals (Comptes Rend. March 1875, p. 681), agrees with Dr. Duncan in keeping the *Monticuliporæ* and others amongst the corals, notwithstanding their Bryozoan characters.

II.—*On the* Colydiidæ *of New Zealand.*

By D. Sharp.

My object in this paper is to describe, in as brief a manner as is consistent with utility, the new species of New-Zealand Colydiidæ which have been sent me by Captain Thomas Broun, of Tairua, and by Mr. T. Lawson, of Auckland, by the hands of his brother, Mr. R. Lawson, of Scarborough. These species are eighteen in number; and in addition to them six previously described species are known to me. These are:—

1. *Enarsus Bakewellii*, Pasc. A very distinct and remarkable form.

2. *Bolitophagus antarcticus*, White. This species should be referred to the genus *Ulonotus*, Er.; with this latter name *Pristoderus*, Hope, is, according to Mr. Pascoe, synonymous; but Mr. Hope's name may be with advantage dropped into oblivion, as it has not been accompanied with any characters by which it can be recognized, and its place in classification was erroneously indicated.

3. *Tarphiomimetes viridipicta*, Woll. This is closely allied to, and congeneric with, *Ulonotus Brouni* here described, and should be classed with it and *Bolitophagus antarcticus* in the genus *Ulonotus*; concerning which name I may here remark that the characters with which it was associated by Erichson were but insufficient, and no species was described; so that I